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## Original Article

# Declining track and field performance trends in recent years in the Austrian best results 1897-2019

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## Abstract

**Objectives:** Plateauing of world records in sports has been suggested to reflect the limits of human physiology. Possible explanations include reduced doping or declining popularity that may even lead to a decrease in human performance. Such a decrease, however, has not yet been observed. We hypothesized that rather than a performance plateau, performance has recently declined. **Methods:** Fifteen athletic disciplines of the Austrian annual rankings were analyzed by regression statistics and the average best performance of the last 20 years compared to earlier periods. **Results:** The best performances occurred between 1980–1999 and were on average 2.56% (men) and 1.67% (women) better than between 2000–2019. This attenuation was significant in men in 200 m, 800 m, 1500 m, 10 km, long jump, javelin throw ( $p<0.05$ ), high jump, pole vault, discus throw, shot put and hammer throw ( $p<0.001$ ); and in women in 400 m, long jump, discus throw ( $p<0.05$ ) and high jump ( $p<0.001$ ). The greatest performance declines were observed in the men's shot put (9.11%) and hammer throw (11.44%). **Conclusions:** The Austrian track and field annual best results show a performance decline following a peak, instead of a plateau. Future studies should address the causes and whether this also applies to other sports and countries.

**Keywords:** Athletics, Competition, Peak Performance, Running, Sports History

## Introduction

Several authors have suggested that peak human performance has reached a plateau in a number of sports including athletics, indicating the limits of human physiology<sup>1-5</sup>. Among others, Weiss et al.<sup>5</sup> predicted a slower but ongoing asymptotic increase in peak sprint and long-distance running performance.

On the other hand, an attenuation in cycling performance

was detected as a result of recent anti-doping strategies efficiently leading to a reduction in the use of performance-enhancing drugs<sup>6-7</sup>. Other possible factors that could result in such an attenuation are an unhealthy lifestyle, environmental pollution and even, at least in theory, the observed increased deleterious mutation load in humans<sup>8</sup>. In addition, a decreasing popularity of physical sports, potentially due to a shift towards other leisure activities or sports, such as e-sports or an overall decrease in interest for physically demanding and competitive hobbies, could show up as a decrease in performance. Part of the decreased popularity may in turn be a consequence of reduced funding and talent identification. An attenuation of peak sports performance, however, has not yet been reported in athletics.

To assess whether there was a decline in performance over the last few decades, we analyzed the Austrian track and field annual best result lists that are available online and date back to 1897. We hypothesized that athletics performance shows a decline, rather than a plateau, in recent years.

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**Table 1.** Averages of each year's best result in seconds and meters. Events were included when the available data reached back to before 1970.

	Men				Women			
	2000-2019	1980-1999	1960-1979	1940-1959	2000-2019	1980-1999	1960-1979	1940-1959
100 m	10.4	10.4	10.5	10.8	11.5	11.7	11.8	12.4
200 m	21.2	20.9	21.4	22.4	23.7	23.7	24.2	26.0
400 m	47.0	47.0	48.1	50.0	54.3	53.4	54.8	58.5
800 m	109	108	110	115	125	123	129	143
1500 m	221	219	225	239	260	259	275	
5000 m	825	819	857	905				
10 km	1765	1729	1820	1941				
110 m hurdles	14.0	13.8	14.5	15.6				
High jump	2.07	2.18	2.05	1.88	1.83	1.90	1.77	1.57
Long jump	7.69	7.86	7.41	7.11	6.34	6.52	6.12	5.54
Pole vault	5.13	5.43	4.64	3.85				
Discus	63.3	58.1	57.5	46.6	53.5	56.0	49.5	42.3
Shot put	17.9	19.5	17.3	14.3	15.2	15.5	14.5	12.9
Hammer	65.2	72.7	67.0	48.9				
Javelin	71.6	75.6	73.8	64.9	52.9	53.6	55.8	43.3

**Table 2.** Peak performance shown in percent of the average of the period 2000-2019. Events were included when the available data reached back to before 1970. Average velocity was used to compute the percentage performance in sprints, runs and hurdles. The year of maximal performance was calculated using the 2<sup>nd</sup> order polynomial regression equations based on the years 1950-2019. Light grey: significant difference (t-Test) to 2000-2019  $p < 0.05$ ; dark grey:  $p < 0.001$ .

	Men					Women				
	2000-2019	1980-1999	1960-1979	1940-1959	Year of max performance	2000-2019	1980-1999	1960-1979	1940-1959	Year of max performance
100 m	100.0	100.4	99.0	96.5	2001	100.0	98.6	97.7	92.9	1996
200 m	100.0	101.3	98.8	94.4	1994	100.0	99.7	97.9	90.8	1995
400 m	100.0	100.0	97.8	94.0	2001	100.0	101.6	99.0	92.8	1993
800 m	100.0	101.4	99.6	94.7	1993	100.0	101.6	96.5	87.6	1995
1500 m	100.0	101.0	98.5	92.4	1996	100.0	100.4	94.3		
5000 m	100.0	100.7	96.3	91.1	1999	100.0				
10 km	100.0	102.1	97.0	90.9	1995	100.0				
110 m hurdles	100.0	101.1	96.5	89.5	1996	100.0				
High jump	100.0	105.1	98.9	90.8	1986	100.0	103.9	97.0	85.8	1991
Long jump	100.0	102.2	96.3	92.4	1997	100.0	102.8	96.5	87.3	1994
Pole vault	100.0	105.9	90.5	75.2	1995	100.0				
Discus	100.0	91.7	90.8	73.5	2031	100.0	104.8	92.6	79.2	1997
Shot put	100.0	109.1	96.5	79.9	1991	100.0	101.9	95.4	84.8	1992
Hammer	100.0	111.4	102.8	75.0	1988	100.0				
Javelin	100.0	105.5	103.1	90.6	1988	100.0	101.3	105.5	81.8	1992
Average	100.0	102.6	97.5	88.1	1997	100.0	101.7	97.3	87.0	1994

## Materials and methods

The Faculty Research Ethics and Governance Committee of the Faculty of Science & Engineering of Manchester Metropolitan University approved the study on November 5<sup>th</sup>, 2019 (Referencenumber: FREGSE\_UG/PGT\_005\_22.10.19). The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. The authors declare that they have no conflict of interest.

### Data collection

The Austrian Track and Field Association (OLV) has published all ranking lists since 1897 on their website (<https://www.oelv.at/de/statistik/bestenliste-archiv>). The best results for each year of each of the following 15 disciplines were collected and analyzed for women and men separately: 100 m, 200 m, 400 m, 800 m, 1500 m, 5000 m, 10 km, high jump, long jump, pole vault, discus throw, shot put, javelin throw, hammer throw and 110 m hurdles.

### Statistical analysis

Disciplines were included in the analysis when the available data reached back to before 1970 (at least 50 years back) to benefit from the long time-span the dataset provides. Two-tailed Student's t-tests were executed with IBM® SPSS® Statistics version 25 to compare peak performance in different periods. Speed was calculated from sprinting and running times to compute percent differences of average best results in different periods. Significance was assumed at  $p < 0.05$ . In the figures, second-order polynomial models are shown as trend lines, since these resulted in the highest  $R^2$ -values. The year of maximum performance was calculated from these second-order polynomial functions ( $f(x) = ax^2 + bx + c$ ) by calculating the vertex using the equation  $x = -b/2a$ .

## Results

Figures 1-5 show the best performance in each year for the male (Figures 1-3) and the female athletes (Figures 4-5) in several athletics disciplines. It can be seen that the best performance dropped in most events after reaching a peak in the 1980s or 1990s. The only exceptions are the men's discus throw and the women's 100 m and 200 m sprints, where performance continued to increase. Table 1 presents the averages of the best performance in seconds and meters, comparing 20-year periods. Table 2 shows the same data as a percent of the performance in the period 2000-2019. The best performances were on average 2.56% and 1.67% higher for men and women, respectively, in 1980-1999 compared to 2000-2019. This attenuation of performance was significant in the following events: men: 200 m, 800 m, 1500 m, 10k m, long jump, javelin throw ( $p < 0.05$ ), in high jump, pole vault,

discus throw, shot put and hammer throw ( $p < 0.001$ ); women: 400 m, long jump, discus throw ( $p < 0.05$ ) and high jump ( $p < 0.001$ ). The greatest performance declines were observed in the men's shot put (9.11% decline) and hammer throw (11.44% decline). In contrast, the men's discus throw showed an 8.26% improvement in performance. The performance in all events was better in the period 2000-2019 compared to that between 1940 and 1959 ( $p < 0.001$ ).

## Discussion

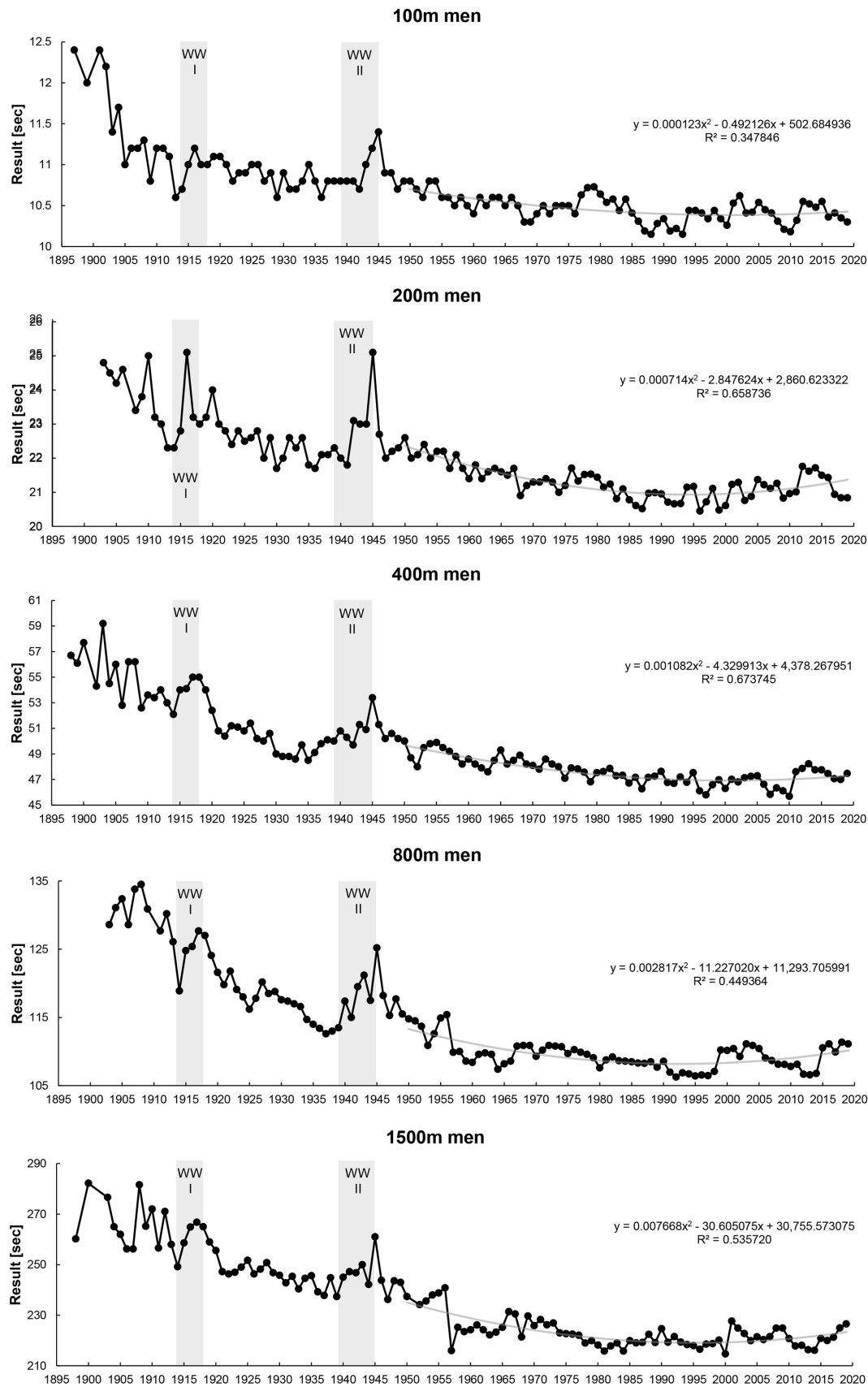
The present study analyzed peak performance trends in 15 track and field events using data from the Austrian annual ranking lists dating back to 1897. In line with the hypothesis, we found a lower peak performance in most disciplines after the year 2000 compared with 1980 to 1999. This is the first study to show such a decline in performance in many disciplines in a first-world country with a population of approximately 9 million people. Several studies have indicated a performance plateau in recent years that was interpreted as an indication that the limits of the human physiology have been reached<sup>1-3</sup>. Weiss et al.<sup>5</sup> even saw the beginning of performance declines, but interpreted them rather as a slower increase in performance than a decline. Our data four years later make it clear that we are indeed dealing with a decrease.

### Factors increasing performance

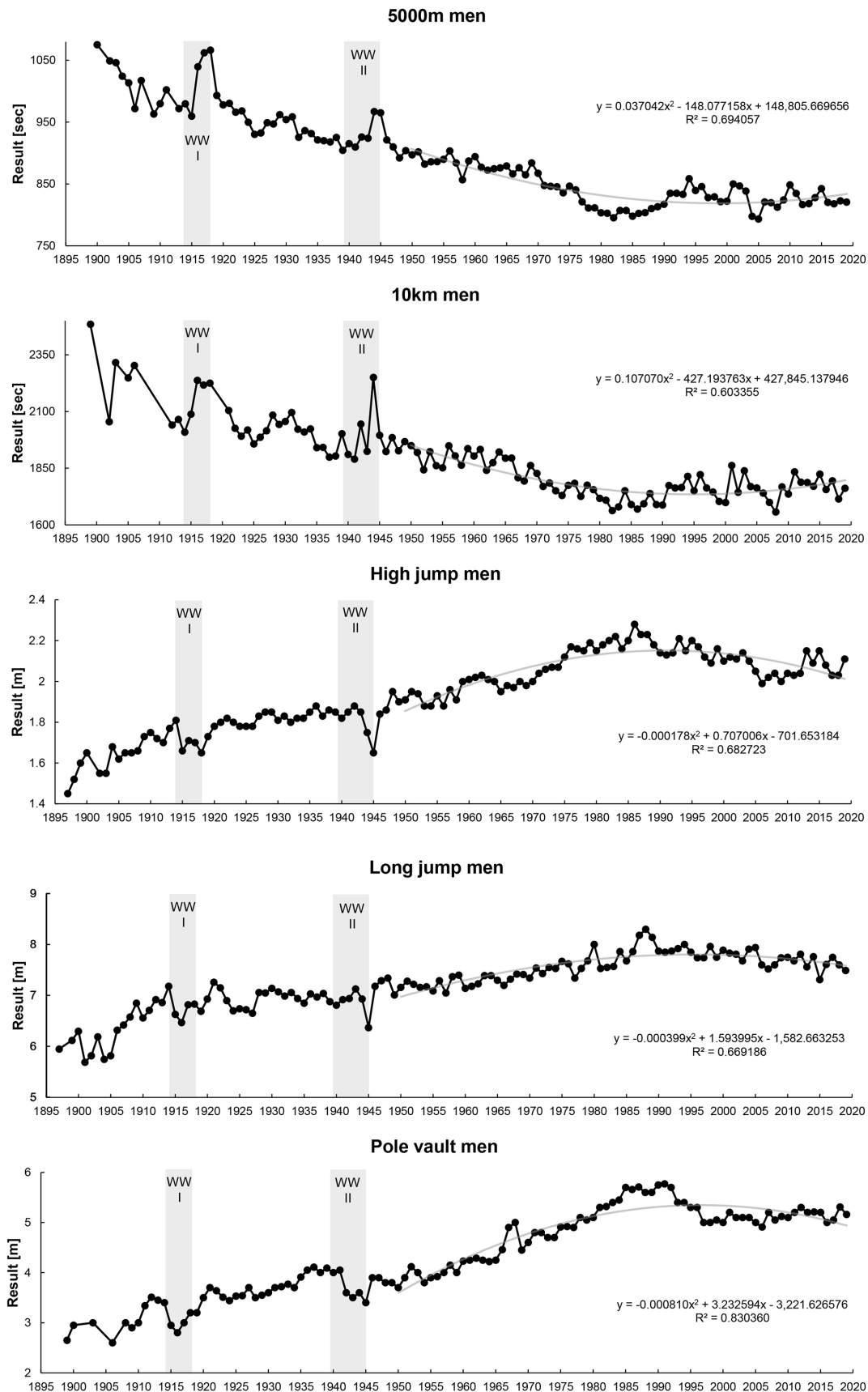
Berthelot et al.<sup>9</sup> identified technological innovations as an important factor for performance increases over the last decades, such as better sports equipment, sport shoes, running tracks, throwing implements and poles. In addition, better living conditions and nutrition have led to an increase in body mass and height during the twentieth century<sup>10</sup>. The latter may result in larger stride length and hence running velocity, as it has been observed that stride length correlates significantly with running speed<sup>11</sup>. In addition, a massive gain in knowledge in the field of exercise and training science resulted in improvements in training programs as well as pacing strategies, which has also helped to increase the peak performance<sup>12</sup>.

### Potential causes of declining performance

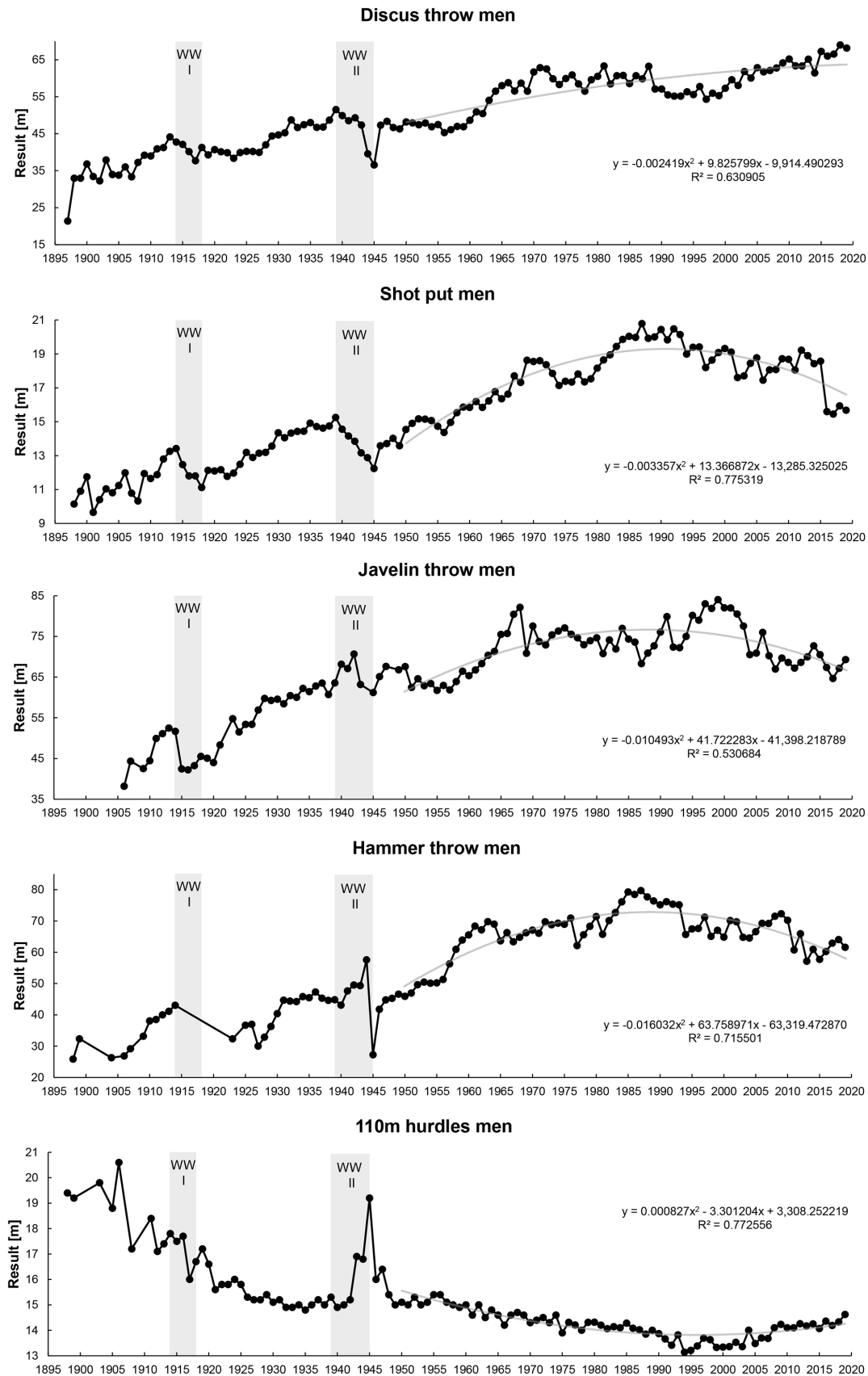
One of the potential causes for the recent decline in performance is a decrease in substance abuse or doping following stricter regulations and punishments<sup>13</sup>. The greatest declines in performance were found in the men's shot put and hammer throw, events that require muscle mass and power that can be improved by anabolic steroids<sup>14</sup>. Weiss et al.<sup>5</sup> speculated that the stagnation or decline of performance levels as a result of the reduced use of anabolic drugs might be more pronounced for women than for men, as women have a lower muscle-mass to body-mass ratio that enables them to benefit more from anabolic substances than



**Figure 1.** The men's best results of each year in sprint and middle-distance running.

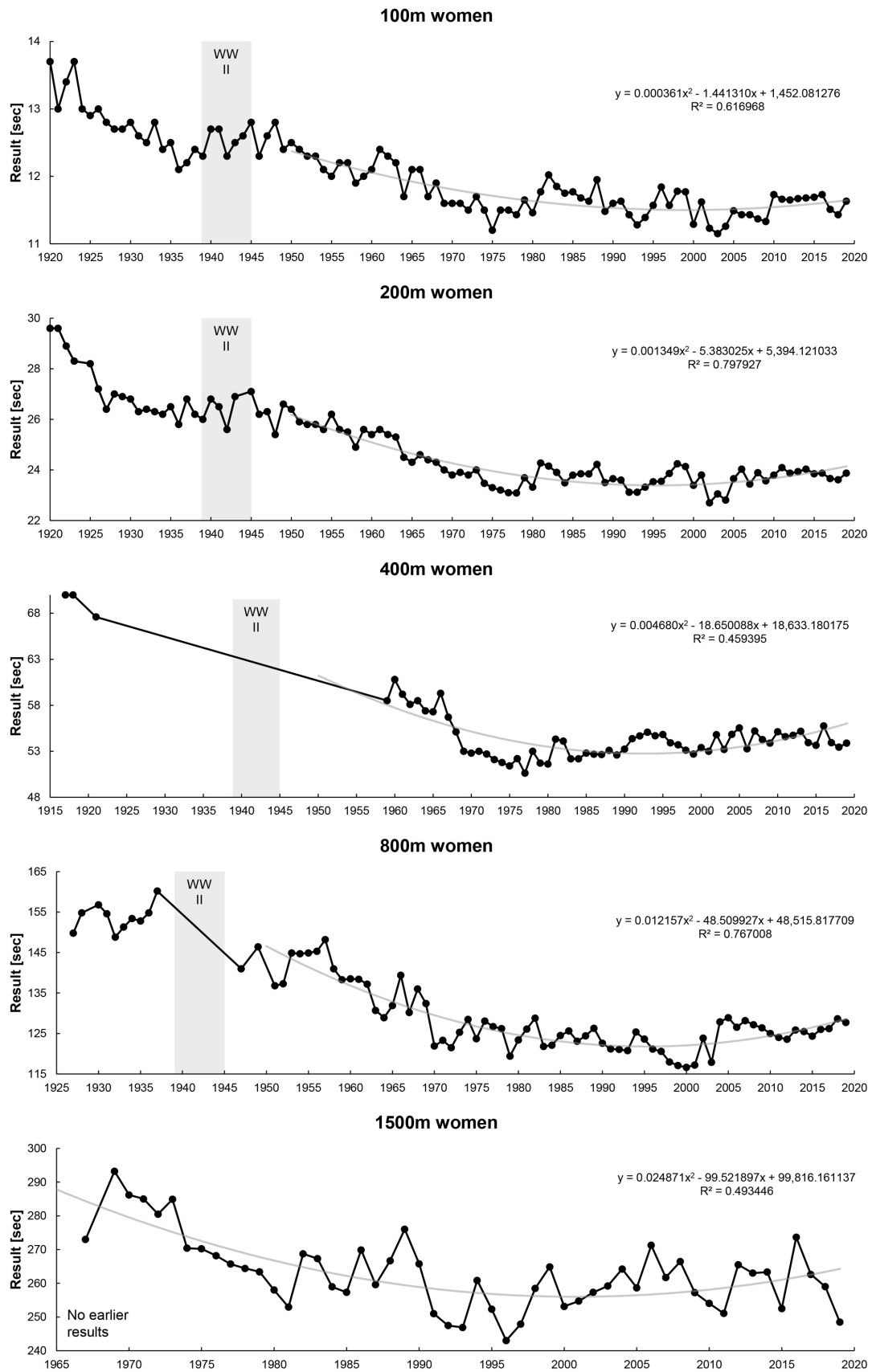


**Figure 2.** The men's best results of each year in long-distance running and the jumps.



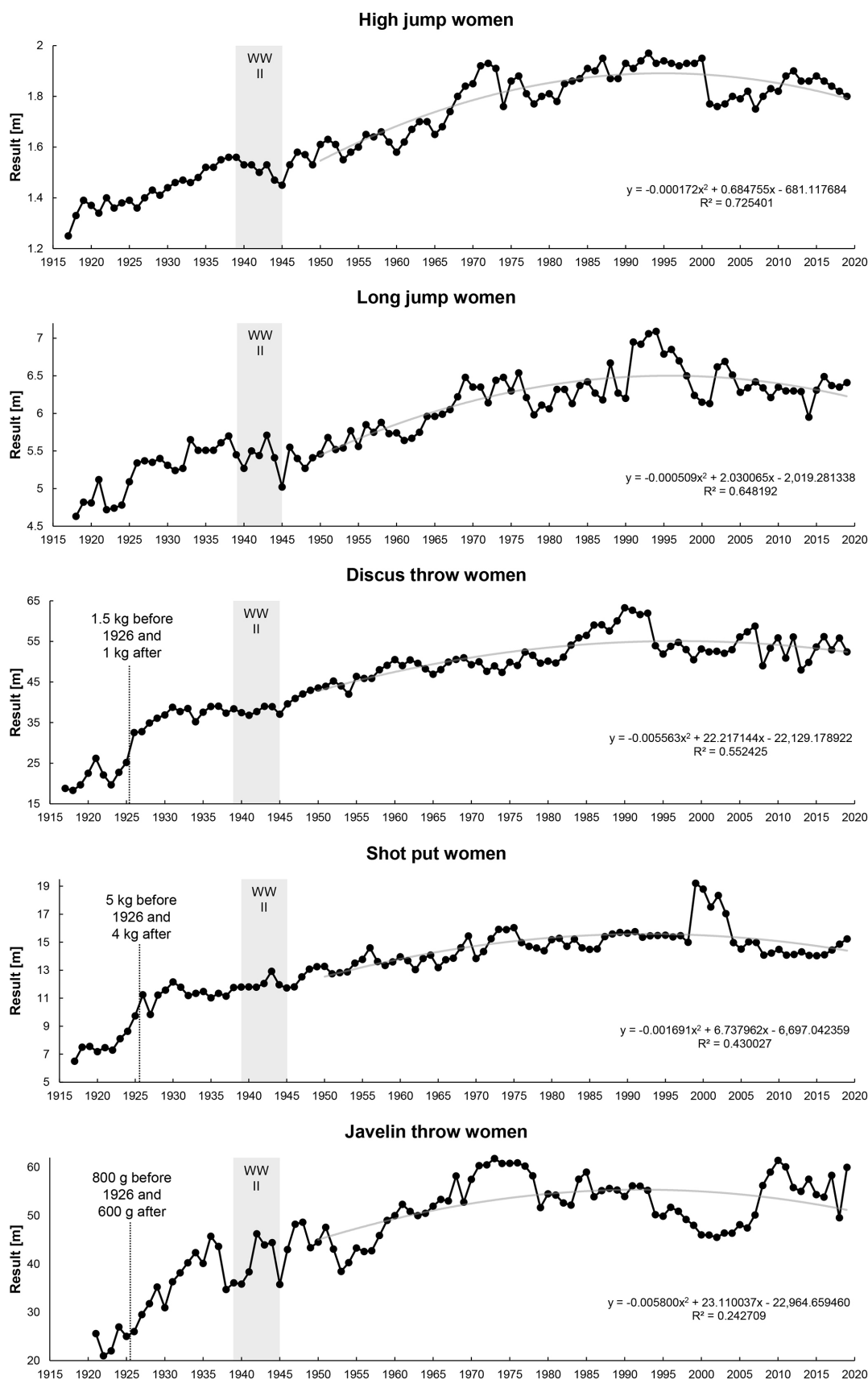
**Figure 3.** The men's best results of each year in the throwing events and short hurdles.





**Figure 4.** The women's best results of each year in sprint and middle-distance running.





**Figure 5.** The women's best results of each year in the jumping and throwing events.

men. This theory is not supported by our data, but rather the opposite, as the recent performance decline was more pronounced in men than women.

Other factors that may underlie the recent reduction in peak performance include a declining interest in the sport, less efficient identification and support of young talents resulting in a smaller pool of talented individuals<sup>15-16</sup>. Such a decreased interest in competitive elite sport might be caused by a multitude of factors, such as time and financial restrictions due to a focus on other hobbies and new emerging sports (for example BMX, surfing, skateboarding, e-sports, and adventure and extreme sports)<sup>17-18</sup>. In addition, socioeconomic factors, such as crises and wars, have a significant impact on sports performance<sup>19</sup>, as reflected also in the current dataset by decreased performance during and immediately after the two World Wars (Figures 1 to 5). Clearly, war is not explaining the recent decline in performance of Austrian track and field athletes, but it might be mediated by socioeconomic changes in modern society, such as an increase in perceived stress, pressure or loneliness over recent years<sup>20-21</sup>.

An increase of the weight of throwing implements would also explain a decrease in performance. Indeed, the decreased weight of throwing implements for women in 1926 was accompanied with an increase in the distance thrown (Figure 5), but no such change in implement weight occurred between the periods of 1980–1999 and 2000–2019. Another specific example of how changes may affect performance independent of human physiology is seen in javelin throw. As several athletes had thrown beyond the end of the grass field in the stadium, it was decided to reduce the distance a javelin could fly by shifting the balance point forward to make it drop earlier<sup>22</sup>. This was first introduced for men in 1986, followed by a similar change in javelin specification for women in April 1999, and in line with the intended effect this was followed by a decreased performance. Nevertheless, in the present dataset the performance declines are even more pronounced in other events, indicating that changes in javelin specifications did not alter the overall outcome of our study.

### Sex differences

For women the rankings for 10 and for men 15 disciplines were available dating back to at least 1970. This corresponds with the increase in proportion of women participating in the Olympic Games from 10.5% in 1948 to 42% in 2008 and may well be attributable to an increased social and cultural acceptance of women in sport<sup>23</sup>. In this context it is interesting to note that the declines in performance in the present study were less pronounced in the women compared to the men, which may be attributable to their lower participation in sports. With regards to changes of physiological parameters over time for both sexes, the development of body size, muscle volume, power and morphology, including fibre type composition, as well as perhaps earlier development of heart and blood vessel stiffness and arteriosclerosis, and hormone levels should be studied and compared

to older data. It could be that part of such changes are attributable to differences in lifestyle and diet, such as an increasingly sedentary life style that has detrimental effects on health even in the face of high activity levels<sup>24</sup> and the consumption of more processed foods.

### Limitations

In the present study only data from Austria were analyzed and may thus not be generalized to what happens in the world as a whole. Nevertheless, Austria is a central European first-world country with a long tradition in competitive track and field and it is therefore likely that similar trends will be seen when analyzing changes in world records over the same period.

### Conclusions

Peak sports performance was thought to have reached a plateau, indicating the limits of human physiology. Our study, however, is the first to show a decline in track and field performance in recent years in Austria, after reaching a peak in the 1980s and 1990s. Causes for this decline may include efficient anti-doping strategies and reduced popularity of athletics in favor of other sports or hobbies. Further research needs to analyze these factors and see if a similar decline can be found in other sports and whether this also applies to world records. For example, data on the physiology and medical status, sedentary life styles and alterations in diet could have a negative impact on muscle volume and strength, cardiovascular health, further compounded by environmental factors such as micro-plastic particles in the body and air pollution effects.

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